configured to be implanted in the skull 700 and an attachment element 2514 configured to be connected to the skull 700 by fasteners 2518 (Figure 2), an adhesive, and/or an anchor. The pulse system 2530 can be identical or similar to any of the pulse systems described above with reference to Figures 6-13, and the first and second electrodes 2560 can have any of the electrode configurations explained above with reference to Figures 14-24. Unlike the stimulation apparatus described above, however, the stimulation apparatus 2500 includes a biasing element 2550 coupled to the electrodes 2560 to mechanically bias the electrodes 2560 away from the support member 2510. In an alternative embodiment, the biasing element 2550 can be positioned between the housing 2512 and the attachment element 2514, and the electrodes 2560 can be attached directly to the housing 2512. As explained in more detail below, the biasing element 2550 can be a compressible member, a fluid filled bladder, a spring, or any other suitable element that resiliently and/or elastically drives the electrodes 2560 away from the support member 2510.

Figure 26 illustrates an embodiment of the stimulation apparatus 2500 after it has been implanted into the skull 700 of a patient. When the fasteners 2518 are attached to the skull 700, the biasing element 2550 should be compressed slightly so that the electrodes 2560 contact the stimulation site. In the embodiment shown in Figure 26, the compressed biasing element 2550 gently presses the electrodes 2560 against the surface of the pia mater 708. It is expected that the biasing element 2550 will provide a uniform, consistent contact between the electrodes 2560 and the pial surface of the cortex 709. The stimulation apparatus 2500 is expected to be particularly useful when the implantable device is attached to the skull and the stimulation site is on the pia mater 708 or the dura mater 706. It can be difficult to position the contacts against the pia mater 708 because the distance between the skull 700, the dura mater 706, and the pia mater 708 varies within the cranium as the brain moves relative to the skull, and also as the depth varies from one patient to another. The stimulation apparatus 2500 with the biasing element 2550 compensates for the different distances between the skull 700 and the pia mater 708 so that a single type of device can inherently fit several different patients. Moreover, the stimulation

apparatus 2500 with the biasing element 2550 adapts to changes as the brain moves within the skull. In contrast to the stimulation apparatus 2500 with the biasing element 2550, an implantable device that does not have a biasing element 2550 may not fit a particular patient or may not consistently provide electrical contact to the pia mater.

Figures 27 and 28 are cross-sectional views of stimulation apparatus in which the biasing elements are compressible members. Figure 27, more specifically, illustrates a stimulation apparatus 2700 having a biasing element 2750 in accordance with an embodiment of the invention. The stimulation apparatus 2700 can have an integrated pulse system 2530 and electrodes 2560 coupled to the pulse system 2530 in a manner similar to the stimulation apparatus 2500. The biasing element 2750 in this embodiment is a compressible foam, such as a biocompatible closed cell foam or open cell foam. As best shown in Figure 27, the biasing element 2750 compresses when the stimulation apparatus 2700 is attached to the skull. Figure 28 illustrates a stimulation apparatus 2800 having a biasing element 2850 in accordance with another embodiment of the invention. The biasing element 2850 can be a compressible solid, such as silicon rubber or other suitable compressible materials. The electrodes 2560 are attached to the biasing element 2850.

Figure 29 is a cross-sectional view of a stimulation apparatus 2900 having a biasing element 2950 in accordance with another embodiment of the invention. The stimulation apparatus 2900 can have a support member 2910 including an internal passageway 2912 and a diaphragm 2914. The biasing element 2950 can include a flexible bladder 2952 attached to the support member 2910, and the electrodes 2560 can be attached to the flexible bladder 2952. In operation, the flexible bladder 2952 is filled with a fluid 2954 until the electrodes 2560 press against the stimulation site. In one embodiment, the flexible bladder 2952 is filled by inserting a needle of a syringe 2956 through the diaphragm 2914 and injecting the fluid 2954 into the internal passageway 2912 and the flexible bladder.

Figure 30 is a cross-sectional view of a stimulation apparatus 3000 having a biasing element 3050 in accordance with another embodiment of the invention. In this embodiment, the biasing element 3050 is a spring and the electrodes

2560 are attached to the spring. The biasing element 3050 can be a wave spring, a leaf spring, or any other suitable spring that can mechanically bias the electrodes 2560 against the stimulation site.

Although several embodiments of the stimulation apparatus shown in Figures 25-30 can have a biasing element and any of the pulse systems set forth above with respect to Figures 6-13, it is not necessary to have a pulse system contained within the support member. Therefore, certain embodiments of implantable stimulation apparatus in accordance with the invention can have a pulse system and/or a biasing member in any combination of the embodiments set forth above with respect to Figures 6-30.



### 5. Implantable Stimulation Apparatus with External Pulse Systems

Figures 31-35 are schematic cross-sectional views of various embodiments of implantable stimulation apparatus having external pulse systems. Figure 31, more specifically, illustrates an embodiment of a stimulation apparatus 3100 having a biasing element 3150 to which a plurality of electrodes 3160 are attached in a manner similar to the stimulation apparatus described above with reference to Figures 25-30. It will be appreciated that the stimulation apparatus 3100 may not include the biasing element 3150. The stimulation apparatus 3100 can also include an external receptacle 3120 having an electrical socket 3122 and an implanted lead line 3124 coupling the electrodes 3160 to contacts (not shown) in the socket 3122. The lead line 3124 can be implanted in a subcutaneous tunnel or other passageway in a manner known to a person skilled and art.

The stimulation apparatus 3100, however, does not have an internal pulse system carried by the portion of the device that is implanted in the skull 700 of the patient 500. The stimulation apparatus 3100 receives electrical pulses from an external pulse system 3130. The external pulse system 3130 can have an electrical connector 3132 with a plurality of contacts 3134 configured to engage the contacts within the receptacle 3120. The external pulse system 3130 can also have a power